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SciVerse ScienceDirect

Procedia Social and Behavioral Sciences 23 (2011) 65–66

Procedia Social and Behavioral Sciences

Academy of Aphasia 2011

Neural Basis of Semantic and Syntactic Interference Resolution in Sentence Comprehension

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Introduction

During sentence comprehension, earlier information must often be linked with later information across some potentially interfering intervening material. For example, for the sentence "The client who had implied that the visitor was important was complaining," "client" has to be retrieved as the subject of "was complaining" across the embedded clause which includes another subject noun ("visitor") that is a plausible agent of "complaining." Interference occurs when the intervening material partially matches the retrieval cues generated by the verb based on semantic and/or syntactic features (Van Dyke, 2007). Such an approach can explain a wide range of sentence processing results, such as the greater difficulty of passive than active sentences and of object than subject relative clauses. In the present study we examined the brain regions involved in resolving interference using fMRI. Previous findings suggest a role for the left inferior frontal gyrus (LIFG) in resolving semantic interference (Kan & Thompson-Schill, 2004) and we wished to determine if a similar or different region would be engaged in resolving syntactic interference.

Methods

Semantic and syntactic interference were manipulated in a 2 x 2 design as illustrated in the Figure. In the low semantic interference conditions, the intervening noun is not a plausible agent of the verb whereas in the high semantic interference conditions it is. In the low syntactic interference conditions, the intervening noun is a prepositional object whereas in the high syntactic interference conditions, it is a subject. Twelve neutrally intact subjects were presented the sentences phrase by phrase and, following the sentence, were asked to verbally respond to comprehension questions.

Results

Regions that showed a main effect of semantic interference or syntactic interference were identified in two voxel-wise contrasts (high vs. low semantic interference conditions; high vs. low syntactic interference conditions, respectively) on the hemodynamic signal changes following the onset of sentences and following the onset of questions ($p_{\text{corrected by cluster threshold}} < 0.01$). As predicted, one region in the LIFG (BA 45) showed greater activation for the high than the low SEMANTIC interference conditions following the onset of the sentences. Interestingly, another region in the LIFG (BA 45) showed greater activation for the high than the low SYNTACTIC interference conditions, but following the onset of the questions. Based on the result of a conjunction analysis ($p_{\text{corrected by cluster threshold}} < 0.01$), these two regions had a large degree of overlap.

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doi:10.1016/j.sbspro.2011.09.172

Sentence					*Comprehension Question*
Phrase 1	*Phrase 2*	*Phrase 3*	*Phrase 4*	*Phrase 5*	
The client	who had arrived	after the important **meeting** *(LOW SEMANTIC and LOW SYNTACTIC interference)* after the important **visitor** *(HIGH SEMANTIC and LOW SYNTACTIC interference)*	that day	was complaining.	Who complained?
	who implied that	the **meeting** was important *(LOW SEMANTIC and HIGH SYNTACTIC interference)* the **visitor** was important *(HIGH SEMANTIC and HIGH SYNTACTIC interference)*			

Figure: An example of a sentence and comprehension question.

Conclusion

The results suggest that the resolution of semantic and syntactic interference during sentence comprehension involves the LIFG, a region often affected in aphasia. Thus, damage to this region, resulting in reduced ability to resolve interference, could potentially explain patient sentence comprehension patterns.

References

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